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Phytotoxicology Assessment Surveys in the Vicinity of Nitrochem Inc., Maitland, Ontario - July 1989 and 1990

Background Information

Nitrochem Inc. manufactures nitric acid and ammonium nitrate. Production processes can potentially emit NOx (nitrogen oxides and nitrogen dioxide), ammonium nitrate particulate, ammonia and sulphur dioxide.

The primary emission sources of NOx (e.g. nitrogen oxides and nitrogen dioxide) are Nitrochem's three nitric acid production plants (stack emissions) and nitric acid storage tanks (vent emissions). The ammonium nitrate production process is a potential source of ammonium nitrate particulate and ammonia emissions. In addition, Nitrochem utilizes a number of boilers which are potential sources of sulphur dioxide. NOx emission is the primary concern for the MOE Southeast Region.

Phytotoxicology surveys were requested in light of the elevated ambient NOx levels (expressed as nitrogen dioxide) which were found on the Nitrochem property in recent years. Between January 1987 and May 1988, an ambient air monitor was maintained by the MOE Southeast Region near the east limit of the plant site and, on numerous occasions, ambient NOx levels in excess of the MOE air quality criteria were measured at this station. In earlier years (1982/83), ambient NOx levels above the air quality criteria also were measured on several occasions at a station off the plant site to the northwest.

Nitrochem's property is located about 2 km east of Maitland. Highway 401 lies along the company's north boundary, while Hwy. 2 and a privately-owned property form the south boundary. The large property along Nitrochem's east boundary is owned by Dupont Canada Incorporated. The properties to the west are owned by Liquid Carbonic Inc. and a private landowner. Both Hwy. 401 and Hwy. 2, and the closest residential properties along these highways, are located about 1 km away from the company's industrial site.

All of the preceding information was extracted from Ms. K. Benesch's Provincial Officers Report (1).

Foliar Injury Caused by Nitrogen-based Gaseous Pollutants

Acute nitrogen dioxide exposure to vegetation can result in irregular, necrotic spots/lesions between the veins and/or along the leaf margins. The necrosis can be white, tan, bronze, light brown to reddish brown or, in some cases, a dark red brown or black colour. Nitrogen dioxide exposure also can potentially cause chlorosis, or increase the green colour (chlorophyll content) of the leaves. Acute nitrogen dioxide injury can resemble sulphur dioxide and, under some conditions, ozone injury.

Gaseous ammonia emissions also can cause interveinal and/or marginal necrotic areas or spots, as well as chlorosis of foliage. The necrosis can be bleached to tan, reddish tan to brown, or dark brown to black. Foliar discolouration, glazing and/or bronzing often is associated with ammonia exposure.

The information in the preceding two paragraphs is based on injury descriptions provided in the literature (3, 4, 5).

Phytotoxicology Field Surveys

The Phytotoxicology vegetation assessment surveys on the Nitrochem property were conducted on July 17 in both 1989 and 1990. The surveys were requested by Ms. K. Benesch, MOE Southeast Region. A Phytotoxicology survey also was conducted in 1973 when the company was owned by Brockville Chemical Industries. In 1973, nitrogen dioxide and ammonia type injuries were observed on vegetation near the company (2) and specimens showing injury were collected.

In 1989, Ms. Benesch accompanied the investigator (R. Emerson) during the survey. The Phytotoxicology investigators (Messrs. Emerson and McIlveen) were accompanied in 1990 by a representative from Nitrochem's Environmental Division.

In both years, vegetation in the vicinity of the perimeter of the Nitrochem plant site was inspected for foliar injury symptomatic of nitrogen dioxide and/or ammonia injury. Vegetation in more remote areas to the north and southwest of the plant site also was examined on the Nitrochem property in 1989 and 1990.

Photographs of foliar injury were taken in both years. Also, in 1990, numerous samples of injured foliage were collected for subsequent storage in the Phytotoxicology Section herbarium. The photographs and herbarium samples were taken so comparisons could be made to injury descriptions/photos in the literature and to injury examples in the herbarium.

Results

In both 1989 and 1990, a variety of foliar injury symptoms were observed on vegetation in the vicinity of the west, north and/or east limits of the plant site. These three general areas are shown as bold numbers 1, 2 and 3 on the attached figure. It was our understanding that Areas 1 and 2 were located on company property. In Area 3, inspections were conducted off company property on the railroad right-of-way. Vegetation in the more remote areas examined did not display any foliar injury that was considered to be associated with emissions from Nitrochem.

In 1989, Manitoba maples in the vicinity of the west (Area 1) and north (Area 2) plant site limits, exhibited whitish to tan, bifacial spots on several mature leaves. Similar injury also was observed on Manitoba maples in these areas in 1990. The spotty or scattered injury observed in both years was of trace to very light severity and was considered to be more typical of wet acid deposits (e.g. nitric acid) than nitrogen dioxide or ammonia emissions.

Also, in 1990, two Manitoba maples growing just east of where the road ended at the north limit (Area 2), exhibited a different, and more severe, type of injury (interveinal, irregular, reddish to tan lesions mixed with marginal necrosis) which, on the basis of the symptoms, could have been caused by nitrogen dioxide or ammonia, or a combination of both. The foliage on the side of both trees exposed to Nitrochem was distinctly brown, with the injury severity ranging from light to severe. There was also evidence of herbicide spraying along the dirt road leading to the area where these trees were growing. Therefore, the possibility that the injury may have been caused by herbicide spray drift can not be ruled out entirely. However, because one affected tree was 30-40 meters away from the immediate herbicide target area, gaseous nitrogen dioxide and/or ammonia emissions from the company also should be regarded as possible causes of the injury. Injured Manitoba maple leaves were collected. The injury that was observed on these two trees in Area 2 in 1990 was very similar to that which was observed on the same species to the west of the company in 1973. This injury was attributed to nitrogen dioxide (2) by the earlier Phytotoxicology report.

In both years, foliar injuries resembling nitrogen dioxide and/or ammonia injury also were observed on white birch and other vegetation in the vicinity of the railroad tracks along the east limit (Area 3) of the plant site. More plant species generally were affected in this area than in Areas 1 and 2, with the predominant leaf injury being tan or reddish brown necrotic lesions. In Area 3, the severity of foliar injury on affected vegetation ranged from trace to severe.

In 1989, foliage on white birch was chlorotic, with distinct reddish brown necrotic lesions. In 1990, chlorosis also was evident, but the reddish necrotic lesions were smaller (less than 1 mm in diameter) and less discrete. White birch is noted in the literature as being sensitive to nitrogen dioxide (5). Also, in 1990, raspberry foliage exhibited a variety of injuries including marginal and/or interveinal chlorosis, tan to reddish tan or dark brown necrosis or lesions, and discoloured (reddish or blackish) tissue areas. In 1973, raspberry foliage near the south and/or west plant site limits also exhibited interveinal and marginal injury accompanied with considerable bronzing that is commonly associated with ammonia fumigation (2). Herbarium samples of injured raspberry foliage were collected in both 1990 and 1973. Upon comparison of these samples, the interveinal injury pattern observed in 1990 resembled nitrogen dioxide injury more than ammonia injury.

A complete list of the affected plants, with associated injury symptoms that were observed in 1989 and 1990, is given on the attached table.

Summary

In summary, the inspections around Nitrochem in 1989 and 1990 revealed vegetation injuries consistent with elevated ambient levels of nitrogen dioxide and/or ammonia in the vicinity of the north and east limits of the plant site. Foliar injury more typical of wet acid deposits (e.g. nitric acid) was observed in the vicinity of the west and north plant site limits. Injury to the east was more typical of nitrogen dioxide or ammonia toxicity.

Literature Cited:

1 MOE Assessment of Nitrogen Oxides Emissions to the Air at Nitrochem Inc., Maitland, Ontario - Provincial Officer Report Prepared by Ms. K. Benesch, July 1991

2 MOE Phytotoxicology Investigation in the Vicinity of Brockville Chemical Industries and Dupont of Canada Ltd., Maitland, Ontario - 1973

3 Recognition of Air Pollution Injury to Vegetation: A Pictorial Atlas, Information Report No. 1, Air Pollution Control Association, Pittsburgh, Pennsylvania, 1970

4 Diagnosis of Air Pollutant and Natural Stress Symptoms on Forest Vegetation in Western Canada, Information Report NOR-X-228, Canadian Forestry Service, Environment Canada, Edmonton, Alberta, 1980

5 Effects of Nitrogen Oxides on Vegetation, In Medical and Biologic Effects of Environmental Pollutants, National Academy of Sciences, Washington, D.C., 1977

Injury Symptoms Observed on Vegetation at the West, North and East Limits of the Nitrochem Plant/Industrial Site, Maitland - July 1989 and 1990

Location (see Figure)	Trees/Plants with Injury	Year	Foliar Injury Symptoms & Severity*
AREA 1 - West side of road along west limit of plant site			
	Manitoba maple	1989	Whitish to tan scattered lesions, trace to light on several leaves.
	"	1990	Injury similar to 1989.
AREA 2 - North and east of road along north limit of plant site			
	Manitoba maple	1989	Injury similar to Area 1.
	"	1990	Pronounced injury on two trees (one by security fence; other 30-40 m north) with tan to reddish tan interveinal and marginal necrotic lesions/necrosis. Light to severe on several leaves, with more severe injury on side exposed to Nitrochem.
	Wild grape	1990	Tan/reddish brown interveinal spots plus marginal necrosis. Trace to light on several leaves.
	Lady's thumb	1990	Reddish tan interveinal lesions. Light on some leaves.
	Sweet clover	1990	Tan marginal necrosis. Light on some leaves.
AREA 3 - West and east of railroad tracks along east limit of plant site			
	Red ash	1989	Reddish tan interveinal lesions. Light to moderate on several leaves.
	White birch	1989	Reddish tan/brown interveinal lesions and chlorosis. Necrosis light to severe on several leaves.
	"	1990	Similar injury as in 1989. Necrosis trace to light on several leaves.
	Wild grape	1989	Distinct chlorosis of middle leaves.
	"	1990	Tan/reddish brown interveinal spots and marginal necrosis. Light to severe on affected leaves.
	Raspberry	1990	Reddish/tan interveinal necrosis/lesions, marginal chlorosis or dark brownnecrosis, discoloured areas. Moderate to severe on several leaves.
	False nettle	1989	Reddish tan to brown interveinal lesions and chlorosis.
	"	1990	Reddish brown interveinal lesions and chlorosis plus lower surface bronze lesions. Light to moderate on affected leaves.
	Goldenrod	1990	Marginal reddish brown necrosis and chlorosis.
	Saint-John's-wort	1990	Reddish brown lesions. Light to severe on affected leaves.

* Trace (<0-1%); Light (2-10%); Moderate (11-35%); Severe (>35%)

Nitrochem Property and Three Areas (1, 2, 3) Where Vegetation Injury was Observed in 1989 and 1990